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Impact of Double-Crested Cormorant Depredations on Channel Catfish Farms

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Abstract

Resurgent wintering populations of double-crested cormorants in the past 10 years have caused serious depredation problems for commercial channel catfish (*Ictalurus punctatus*) growers in Mississippi. Catch rates of catfish by cormorants were found to average 5 catfish per cormorant-hour. Catfish taken averaged 12 cm in length. However, cormorants took fingerling catfish at rates as high as 28 per cormorant-hour. The average number of cormorants found feeding on a single pond in this study was 30.5. If this number (but not necessarily the same individuals) fed all day in an 8 ha pond stocked at 51,000 fish/ha, the fish population would be halved in 30 days. Further, using this example, the cost of harassment patrols on a 200 ha catfish farm complex over a 5 month period would be exceeded in 22 days by the losses in this one pond. Wild gizzard shad (*Dorosoma cepedianum*) occurred in some ponds, and seem to be preferred by cormorants over catfish.

The commercial catfish industry grew from zero ha in 1965 to over 34,000 ha in 1986 in the Delta region of Mississippi (Wellborn 1987). Since then, expansion has slowed somewhat, but as of May 1991, over 41,000 ha of catfish ponds existed in the Delta (Brunson 1991). Growth of the industry has been accompanied by increases in depredation by fish-eating birds. A 1988 survey of 281 Mississippi catfish growers revealed that 87% perceived fish-eating birds to be enough of a problem to warrant harassment efforts (Stickley and Andrews 1989). In this survey, the value of fish loss to double-crested cormorants (*Phalacrocorax auritus auritus*) alone was estimated at $3.3 million, and efforts to control cormorant, great blue heron (*Ardea herodias*), and great egret (*Casmerodius albus*) depredations were estimated to cost an additional $2.1 million.

Schramm et al. (1984) observed 13 double-crested cormorants (*floridanus* subspecies) on 20 randomly selected days in September/October feeding on stocked fingerling channel catfish in south Florida. They estimated that an individual cormorant was taking approximately 304 g of catfish daily. That rate is consistent with the 350–420 g/day intake of captive Florida cormorants reported by Wetmore (1927). However, data apparently do not exist that would allow an accurate determination of the feeding rates of the larger *auritus* subspecies that forage on catfish ponds in the Mississippi Delta from November through April. The purpose of this study was to determine the impact of cormorant depredations on commercial catfish populations in the Mississippi Delta.

Materials and Methods

Sixteen different pond complexes were selected for cormorant depredation surveys from December 1989 through April 1990.

Selection of Complexes and Ponds

Complexes were selected on the basis of growers' expectations of depredations and their willingness to allow observation of cormorants feeding undisturbed on their ponds. Within the complexes, ponds were identified that were most likely to receive cormorant use.

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Fish size, fish density, and pond acreage information were obtained from each grower for each pond on which cormorant feeding observations were made. This information was used to help determine the impact of cormorant feeding on the fish populations.

Observation Techniques

Observations were primarily made from two one-person tents placed adjacent to each other on or near the levee of the pond to be observed. At other times observations were made from a parked vehicle partially obscured by farm machinery. Observations began in the morning at the time cormorants were anticipated to arrive at the ponds and were generally confined to one day for each specific pond.

To keep a minute-by-minute count of the number of cormorants in the pond, Observer #1 verbally recorded on audio tape the number of cormorants arriving and departing during consecutive 1 min intervals beginning with the arrival of the first cormorant. For example, if the first cormorant landed during the minute beginning at 0806 h (and no other cormorants landed during this minute), this would constitute one cormorant-minute for the minute interval beginning at 0806 h. Three more cormorants arriving during the minute interval beginning at 0807 would make a total of four cormorant-minutes for that interval, and, conversely, one cormorant leaving during the 1 min interval beginning at 0808 h and with no arrivals would make a total of three cormorant-minutes for that interval, etc. Likewise, at the end of the observations, if the last 30 cormorants present on the pond flushed during the 1 min interval beginning at 1544 h, 30 cormorant-minutes would be recorded for this 1 min interval. At the end of the observations, a total of cormorant-minutes for this entire observation period was calculated.

Concurrently, using binoculars or a spotting scope, Observer #2 scanned the selected pond from left to right at 5 min intervals, and recorded the number and species of fish seen in the bills of cormorants on the pond surface. Each scan, or sweep, covered the pond surface once, and was synchronized to begin with a new 1 min period for Observer #1. The length of each sweep was recorded to the nearest second.

Between sweeps, Observer #2 recorded as many instances as possible of the time cormorants took to manipulate catfish in their bills and swallow them (starting from the time the birds first emerged from the water with fish). However, timing a cormorant from the moment it first emerged with a fish was difficult because such chance encounters were rare. Almost all cormorants with fish in bills were encountered after the bird had emerged from the water. Three seconds were arbitrarily added to each recorded handling time to allow for the momentary delay in starting the stopwatch after the bird with the fish was spotted.

Observer #2 also recorded the approximate length of each of these catfish by comparing the length of the fish with the known mean distance between the tip of the cormorant's bill and the back of its head of approximately 15 cm.

Determination of Catch Rate

The number of catfish caught by cormorants during a sweep was calculated by multiplying the number of catfish counted during the sweep (C) times the ratio of the length of time of each sweep of the pond (A) to the average catfish handling time by cormorants on that pond (B):

$$\text{Number of catfish taken in a given sweep} = (C)(A/B).$$

For example, if the average handling time for cormorants in a particular pond was 60 s, and a sweep of the pond was made in the same length of time, then the number of catfish seen in the bills of cormorants during that sweep (e.g., 25) equaled the number of catfish that were actually caught during the time of the sweep. Thus:

$$(C)(A/B) = (25)(60/60) = 25$$
(no. of catfish in sweep).

However, if a sweep took longer to complete than the length of the average handling time, the number of fish seen during the sweep period was adjusted upward. For instance, if a particular sweep (from left to right) took 120 seconds, and the handling time remained 60 seconds, then the number of fish seen in the bills of cormorants during that sweep (e.g., 25) was doubled; thus:

$$(C)(A/B) = (25)(120/60) = 50$$
(no. of catfish in sweep).

This calculation corrects for the inclusion of fish caught on the right side of the pond and swallowed before the scope sweep reached that side. It also corrected for the inclusion of fish caught and swallowed on the left side of the pond after the observer had swept that area but before he had completed the sweep on the right side.

Conversely, if the sweep time (30 s) was shorter than the average handling time (60 s), then the number of catfish seen in the bills of cormorants (25) was adjusted downward to eliminate fish observed in the bills of cormorants during the short sweep but not swallowed before the end of the sweep. Thus:

$$(C)(A/B) = (25)(30/60) = 12.5$$
(no. of catfish in sweep).

When a cormorant was observed diving with a fish already in the bill, the time the bird spent underwater was recorded (if the bird could be spotted when it surfaced). This enabled calculation of the fraction of the total fish handling time that the bird spent underwater, and thus, conversely, the percentage of time spent on the surface of the water. The mean fraction for all recorded instances of the percentage of time spent on the surface was known as the "S-factor." This factor was divided into the number of fish seen on each sweep. This upward adjustment was made to compensate for the unseen number of catfish in the bills of cormorants underwater as the spotting scope sweep was made. Thus, the adjusted number of catfish seen on a given sweep equaled:

$$\frac{(C)(A/B)}{\text{S-factor}}$$

where C = 25; A = 30; B = 60; and the S-factor is 0.95 (i.e., 95% of the time a cormorant is handling a catfish, the bird is on the surface of the water):

$$\frac{(25)(30/60)}{0.95} = \frac{12.5}{0.95} = 13.2 \text{ (no. of catfish in sweep).}$$

In summary, the fish catch for each sweep was estimated, and then the catches for all sweeps made on a particular pond were totaled. This total was divided by the S-factor to adjust for time spent underwater by cormorants handling fish. Then, the number of cormorant-minutes for that pond (as determined by Observer #1) was divided into the adjusted fish catch. This gave the number of fish caught per cormorant-minute for each pond. The handling time used was the average catfish handling time observed for cormorants on a particular pond. If less than ten handling times were available for a pond, the average catfish handling time for all cormorants was used instead for that pond.

Feeding rates on a "cormorant-hour" basis were summarized. For example, 10 cormorant-hours (600 cormorant-minutes) would equate to 100 cormorants on the pond for 6 min or 20 cormorants on the pond for 30 min, etc. A one-way analysis of variance was used to determine if catfish handling times differed among ponds. Linear correlation analysis was used to determine correlations between other factors.

Results and Discussion

A two-man observer team watched 19 ponds during 31 days between 10 December 1989 and 19 April 1990 for 119 total hours. The mean time spent per pond was 6.3 hours (SE = 0.97). Individual sweep times averaged 32.5 seconds (range from 1 to 163 s; SE = 0.75).

Data from 14 of the 19 ponds observed were used in this paper. Three ponds that had virtually no cormorant use were excluded. Another pond was excluded because cormorants were using it to loaf rather than feed. An average of 502 birds were rafted up and loafing on it at any given time. The other pond was excluded because a severe fish die-off was occurring during observation. Cormorants carried dead fish around in their bills for two to ten minutes before dropping most of them, and this was not considered to be normal feeding behavior.

Each pond was considered as a separate entity and observations made on different dates at a given pond were combined (Table 1). Ponds 10 and 14 were exceptions. Pond 10 consisted of two adjacent ponds observed on 8 March 1990, whereas Pond 14 refers only to the southernmost of these same two ponds, which was observed on 9 March 1990.

TABLE 1. *Catfish population characteristics in ponds on which cormorant feeding observations were made, Mississippi, USA, winter 1989–1990.*

Pond no.	Date observed	Pond size (ha)	No. catfish per ha	Catfish length (cm)
1	22 Feb 90	5.7	175,400	13
2	23 Feb 90	6.9	8,700	23
3	8 Feb 90	4.9	4,100	29
4	14 Dec 89	6.9	(2,900)	41
			(5,000)	13
			7,900	
5	19 Apr 90	8.0	(6,500)	29
			(8,400)	23
			(12,500)	14
			27,400	
6	23 Mar 90	21.0[a]	24,700	23
7	27 Mar 90	7.3	24,700	15
8	4 Apr 90	7.5	(12,000)	31
			(18,000)	11
			30,000	
9	13 Dec 89	3.4	19,800	25
10	8 Mar 90	16.2[a]	61,700	13
11	14 Mar 90	5.3	114,000	13
	15 Mar 90			
	16 Mar 90			
	20 Mar 90			
12	6 Feb 90	5.4	18,500	18
13	18 Apr 90	5.7	(14,800)	29
			(18,500)	10
			33,300	
14	9 Mar 90	8.1	61,700	13

[a] These areas each represent two ponds observed as one.

Catfish Handling Times

Only cormorants with fish struggling in the bills (indicating that the fish were freshly caught) were used to calculate handling times. The mean handling time was 47 s (adding in the arbitrary 3 s) (SE = 3.9) for these 117 cormorants. There is the possibility for bias in the direction of longer handling times that would reduce the feeding rate. However, a mean time of 47 s is not unrealistic considering that the mean of 24 exact handling times obtained by fortuitous observation of cormorants at the instant they emerged from the water was 48 s (SE = 12.0).

Of 269 cormorants observed handling catfish, 34 (13%) dove with the fish in the bill. On average, these 34 birds were recorded on the surface with fish 63% of the total handling time. However, when this S-factor was extended to include all 269 cormorants observed with catfish, the average cormorant was found to spend 95% of the total handling time on the surface of the water (S-factor of 0.95; SE = 0.01).

Cormorant Feeding Rates

Consumption rates ranged from zero to 28 catfish consumed per cormorant-hour (Table 2). The average for all ponds was 5 catfish per cormorant-hour (SE = 2.2). The average number of cormorants observed per hour for these 14 ponds was 30.5.

At Ponds 1 and 2 feeding rates of zero were recorded. Catfish were caught but were not observed in the bills of cormorants during the sweep periods. However, in both of these instances only a limited number of sweeps (14 and 20, respectively) were made. The mean number of sweeps per pond was 33 (SE = 6). The low feeding rate in Pond 3 may have been due to the large catfish it contained (29 cm average length according

TABLE 2. *Catfish consumed per cormorant-hour in relation to mean number of cormorants per minute, Mississippi, USA, winter, 1989–1990.*

Variable	Pond													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Fsh/cm-h[a]	0	0	0	0	1	1	2	2	2	3	4	5	20	28
Cm/min[b]	8	41	87	44	44	9	4	7	122	10	2	24	20	6

[a] Catfish consumed per cormorant hour.
[b] Mean cormorants/minute.

to the grower). The low catfish consumption rate in Pond 4 was likely due to the apparently more attractive shad population in that pond (see below).

Ponds 13 and 14 demonstrated the high damage potential of cormorants. Observations on Pond 14 were made over a 3 h period during which the numbers of cormorants varied from 1 to 19 (mean = 4.8). The feeding rate here was 28 catfish (each approximately 13 cm in length) per cormorant-hour. At Pond 13, the feeding rate was 20 catfish (each approximately 10 cm) per cormorant-hour. The number of cormorants varied from 1 to 85 (mean = 20.4). At each site, cormorants continually arrived and departed. The cormorants fed voraciously throughout their comparatively short feeding bouts.

Correlation Between Cormorant Numbers and Catfish Consumption Rate

For each pond, catfish consumption was paired with the corresponding mean number of cormorants present during any given

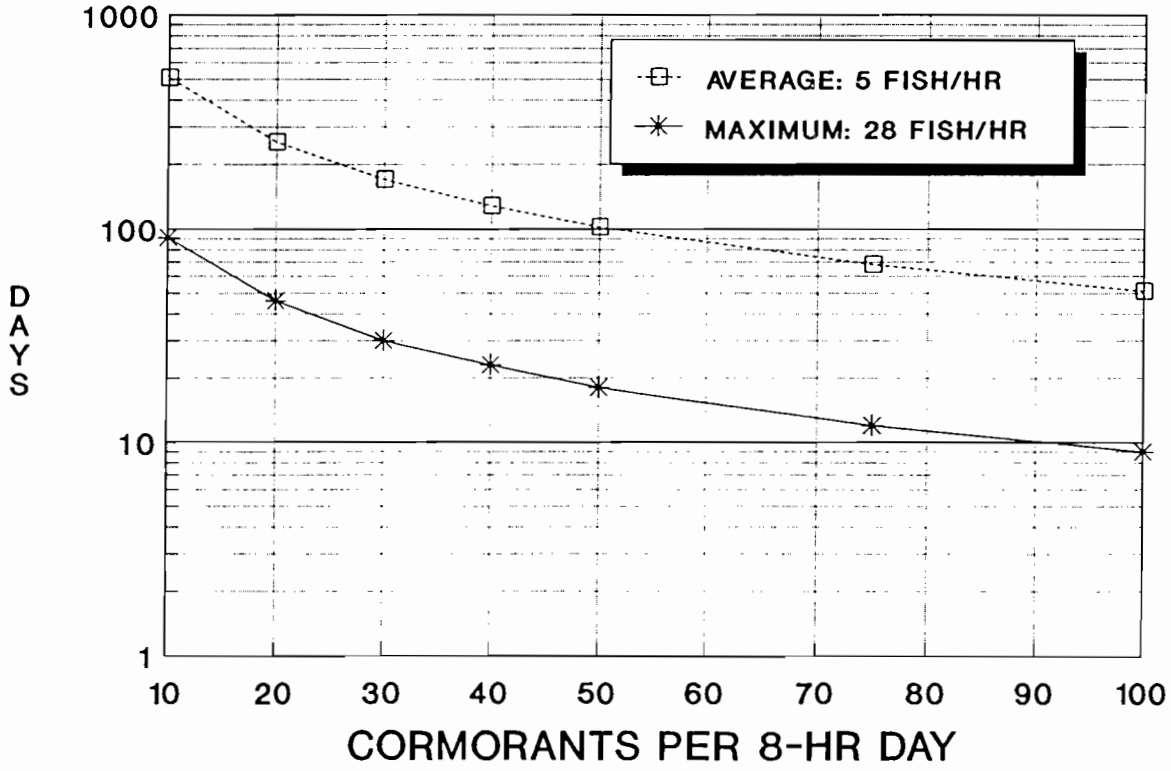

FIGURE 1. *Number of days until an average catfish pond population of 51,000 fingerlings per ha would be reduced by one-half due to varying cormorant-hours of use at average and maximum-recorded consumption rates, Mississippi, winter 1989–1990.*

TABLE 3. *Impact of cormorant feeding on fingerling catfish populations at a cost of $.09/14 cm fingerling (personal communication, Mississippi State Extension Service, April 1991).*

Feeding rate h[a]	Cost/ cormorant-h	Cost/30.5 cormorant-h
Average (5 fish/h)	$0.44	$13.45
Highest recorded (28 fish/h)	$2.48	$75.64

[a] Mean number of cormorants observed per hour for the 14 ponds (Table 2).

minute on the pond. There was no statistical correlation ($r = -0.26$, $P > 0.37$) between the mean number of cormorants present and the number of catfish consumed per cormorant-hour (Table 2). In this study, with one exception, an average of 40 or more cormorants on a pond corresponded to a feeding rate of approximately 1 catfish or less per cormorant-hour. The exception, Pond 9 (Table 2), was adjacent to an active day roost, and thus was subject to much higher feeding pressure than the other ponds. Generally, cormorants spread out on a pond when they were feeding instead of loafing in tightly grouped rafts of birds.

Length of Catfish Consumed

The average estimated length of 269 catfish observed being consumed by cormorants was 12 cm (SE = 0.08, range = 5.0 to 30.5). This mean estimated length is only slightly less than the mean length (15 cm, SE = 2.70) of catfish found in cormorant stomachs from the same area in Mississippi (unpublished data, May 1991). There was a significant correlation ($r = 0.54$, $P < 0.0001$) between catfish lengths and handling times. The larger the fish, the longer the handling time.

Cormorant Preference for Shad over Catfish

Unlike the other study sites, Pond 4 contained gizzard shad (*Dorosoma cepedian-*

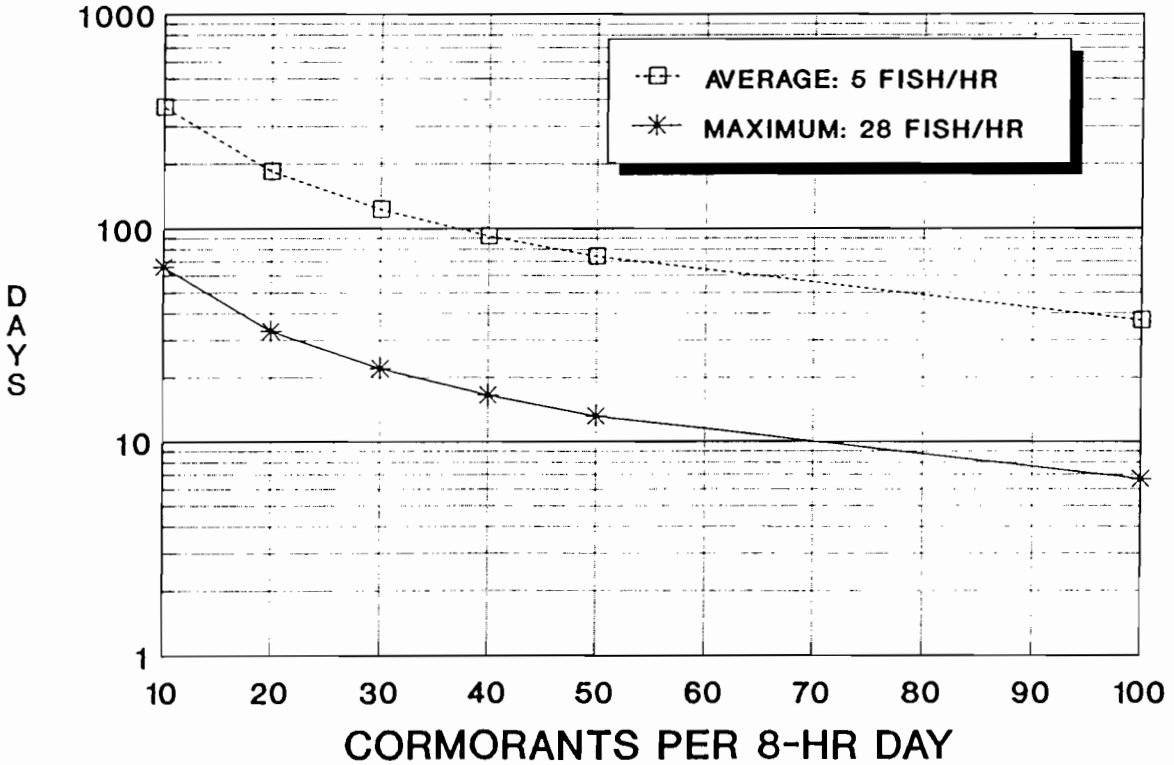

FIGURE 2. *Number of days until cost of harassment for 5 months is exceeded by cost of depredation by varying numbers of cormorants feeding at average and maximum-recorded rates of consumption, Mississippi, winter 1989–1990.*

um) in addition to catfish. In nearly 3 hours, observers noted 64 shad, but only 2 catfish in cormorant bills. This amounts to a feeding rate of 19.2 shad per cormorant-hour compared with a feeding rate of only 0.14 catfish per cormorant-hour. According to the grower's estimate, the 6.9 ha pond contained 13,700 kg of catfish averaging 0.68 kg each plus 35,000 13 cm catfish fingerlings.

This apparent preference for shad over catfish may be due to cormorants being able to handle and swallow shad more easily. The mean handling time for 13 shad was 7.2 seconds (SE = 1.6), as opposed to 47 seconds for catfish. Cormorants were not observed diving with shad in their bills.

Impact of Cormorant Feeding on Fingerling Catfish Populations

At their highest feeding rates, cormorants could have a devastating impact on catfish fingerling populations over time (Fig. 1). The average number of cormorants (30.5) seen feeding on the 14 ponds in Fig. 1 for 8 hours per day at a mean rate of 5 catfish/cormorant-hour would consume half of the average fingerling population surveyed in this study (51,000 fish/ha) in a 8 ha pond in 167 days. At the maximum observed feeding rate of 28 catfish/cormorant-hour, the fingerling population would be halved in 30 days.

The financial impact of these depredations, if allowed to occur, would also be great. An average of 30.5 cormorants feeding for an hour at the average consumption rate would cost $13.45, whereas the cost would be $75.64 per hour at the highest recorded rate (Table 3).

Obviously, growers have to repel these birds or likely suffer high economic losses over time. Littauer (1990) estimates that harassment patrols necessary to keep cormorants off a farm of 200 ha or less for 5 months is in excess of $13,000/year at 1990 prices. This cost would be exceeded in 121 days by an average of 30.5 cormorants feeding all day at the average consumption rate and in only 22 days at the maximum observed rate (Fig. 2).

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